Observations of hydrides with ELT-METIS and JWST in irradiated environments: powerful diagnostics of physical conditions.

Marion Zannese

Institut d'Astrophysique Spatiale

Most forming planetary systems reside in environments irradiated by massive stars (Winter et al. 2022), and it is likely that the Solar System formed under such conditions (Adams 2010). With its extensive spectroscopic capabilities in the near- and mid-infrared, JWST is providing unique access to these irradiated regions, such as photodissociation regions and irradiated disks. The ELT-METIS instrument, thanks to its higher spatial resolution (6 times better) and spectral resolution (30 times better) in a similar wavelength range as JWST-NIRSpec (3-5 μm), will complement the existing and future JWST observations by being able to spatially resolve small targets and giving access to the dynamic of these objects.

Hydrides, such as CH^+ and OH, are key molecules to study physico-chemical processes in strongly irradiated environments and are expected to produce the brightest emission in the ELT-METIS bands (with H_2 and CO). Their faint emission has been detected in various environments with JWST: PDRs (e.g., the Orion Bar (Zannese et al. 2025), NGC 7023 (Misselt et al. in press)), photoevaporated winds of irradiated disks (e.g. d203-506, Zannese et al. 2024-2025), transition disks (e.g. TW Hya, Henning et al. 2024). In this presentation, I will present how their coupled observations with both instruments will provide strong constrains on physical conditions of irradiated regions, either on temperature, density and on our understanding of warm chemistry. Indeed, the analysis of their emission in JWST data revealed out-of-equilibrium excitation processes such as chemical pumping (e.g. $C^+ + H_2(v,J) = CH^+(v',J') + H$) or prompt emission following the photodissociation of water ($H_2O + h\nu = OH(v,J) + H$) which can be use as robust diagnostics. I will focus on how ELT-METIS will bring the missing pieces of the analysis of hydrides emission, such as their none detection in some irradiated disk (e.g., XUE1 observed in NGC 6357, Ramírez-Tannus et al. 2023). With its high spatial resolution and access to the hot gas dynamic, ELT-METIS will allow the separation of the different components of the disk (photoevaporated wind, inner disk, jet) and thus provide a better understanding of the spatial origin of these UV-induced processes.

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